MODEL 304B

RUBIDIUM FREQUENCY

STANDARD

Serial No. 328

GENERAL TECHNOLOGY CORP.

9610 Bellanca Avenue, Los Angeles, California 90045, AC 213 / 670-5541

Home Office: TRACOR Inc., 6500 Tracor Lane, Austin, Texas 78721 AC 512 / 926-2800

TRACOR™

MODEL 304B

RUBIDIUM FREQUENCY

STANDARD

Serial No. 328

Digitized by the Internet Archive
in 2026

https://archive.org/details/manualsplus_11593

1. GENERAL DESCRIPTION

1.1 Description. A brief description of the standard, along with general specifications, is given in the Technical Data Sheet on the following page.

1.2 Equipment Supplies. An MS-3106A-10SL-3S connector for use in connecting the standard to a DC power source is supplied.

1.3 Accessories Available.

1.3.1 Standby Power Supplies. In applications where the standard must operate during times of primary power interruption either the Model 311-A or 311-B Standby Power Supply may be used. Both supplies use sealed nickel-cadmium cells. The 311-A charges at a gradual rate satisfactory in most applications. The 311-B provides rapid recharging.

1.3.2 Time Scale Selector. The gas cell of each rubidium standard is made to a specified International Time Scale. Those units on UT-2, Universal Time, may need a new gas cell each time a new value of UT-2 time is announced because the fine tuning control will not usually cover such changes.

The gas cell can be changed at the factory, but the user must be without his standard for 30-45 days while the change is being made. General Technology Corporation has developed a step synthesizer, called the Time Scale Selector, which can be included in the Model 304-B (or added later) and which provides quick changes of time scale and encompasses a range from Ephemeris Time (zero reference) to about 600×10^{-10} below Ephemeris.

2. INSTALLATION

2.1 Unpacking and Inspection. Inspect for damage in shipment immediately on unpacking the instrument. If reshipment is expected, save the shipping container. If the instrument is damaged in any way, notify the carrier.

2.2 Installation. The instrument may be rack mounted or operated on a bench. Remove the four rubber feet prior to mounting in a rack. Holes in the side panels are located to accept "Chassis-Trak" brand CTD type slides. In bench operation the rubber feet should be in place, or some other means used to provide ventilation space between the instrument and the bench.

2.3 AC Power. The power cord should be plugged into a three-prong receptacle of the NEMA approved type. If a two-prong adapter is used, the external adapter wire to ground should be grounded. Input power required is 115 VAC (nominal), 50-400 cps.

2.4 DC Power. For operation from DC the positive supply lead should be connected to pin A of the connector at the rear of the instrument and the negative (ground) to pin B. A mating connector type MS-3106-A-10SL-3S is supplied. For proper DC operation, the supply voltage should not fall below 23 volts. If both AC and DC power are applied simultaneously, power will be drawn from the external DC supply only if the AC line is below approximately 90 volts.

2.5 Ambient Magnetic Fields. The instrument will be affected somewhat if operated in regions of large AC or static magnetic fields. For best operation, the static ambient field should not exceed three gauss (the earth's magnetic field is about one-half gauss).

2.6 Installation of Time Scale Selector Kit.

Remove power from the rubidium frequency standard during installation of the Time Scale Selector.

The installation kit consist of one (1) Time Scale Selector Board 9 and one (1) crystal filter and mounting bracket.

2.6.1 Remove Boards 2 and 3.

2.6.2 Remove the three red jumpers on Board 2 as indicated in Dwg. G-34112. Solder two jumpers indicated with wire provided.

2.6.3 Remove the red jumper in Board 3 as indicated in Dwg. G-34111.

2.6.4 Remove paper back from part number tag provided and place securely over old part number.

2.6.5 Replace Boards 2 and 3 in their respective slots.

2.6.6 Place Board 9 in Board 9 slot.

2.6.7 Place crystal filter and bracket on the chassis where indicated in Final Assembly (Item 26 - Dwg. G-52288). Fasten in place with the two screws provided.

2.6.8 There are two unterminated cables marked with filter-in (P28) and filter-out (P29). These are spot tied together with black lacing cord. Connect the input cable to the input terminal of the filter. Connect the output cable to the output terminal.

NOTE: Board 9 MUST BE REMOVED BEFORE BOARD 8.

3. OPERATION

3.1 Initial Checks. With AC power applied, throw the front panel power switch to the "ON" position; the front panel red indicator will light. If operation is from external DC power, the instrument is energized independent of the position of the front panel power switch. The three small switches on the internal panel (accessible on opening the hinged cover on top of the instrument) should all be in the left hand position, i.e., with toggles toward the meter. The OSCILLATOR FREQUENCY CONTROL dial on the internal panel should be set at approximately mid-scale or at the value last determined in periodic maintenance. In initial use the value set at the factory and recorded in Table 5-1 is appropriate.

3.2 Warmup. A warmup period of at least one hour, and preferably two hours, is recommended. During the warmup period a slight audible click may come from within the instrument at approximately 30 second intervals. This is due to a relay closure initiating the frequency sweep of the automatic search circuits. The click may be accompanied by a momentary flash of the front panel indicator lights.

Within an hour the AFC loop will come into lock. In this condition the front panel red light indicator is off and the green light is on. The instrument may then be used, but accuracy is somewhat reduced, perhaps 1×10^{-9} or better; specified accuracy and stability are not achieved until after the full warmup period.

3.3 Outputs. The outputs are nominal 50 ohms with a power level of at least 10 dbm. If not properly terminated the output waveforms will be distorted, but with no effect on accuracy or stability.

3.4 Fine Frequency Adjustment. Output frequency of the standard may be adjusted over a range of about 5×10^{-9} by means of the FINE TUNING control dial; it is accessible on opening the top cover. Two calibration charts associated with this control are provided. One gives the control dial setting vs. frequency change; the other shows the control dial change required to cause a frequency change of 1×10^{-11}. It should be noted that the control is not linear; at the high end of the scale a unit dial change produces a larger frequency change than at the low end. The dial is set at the factory to make the output frequencies correspond to the desired time or frequency scale. This setting is recorded in Table 5-1. The dial may be locked to prevent inadvertent movement. This adjustment is also used during Time Scale changes (See Section 6).

3.5 Monitoring Functions. The internal panel containing the LOOP ERROR SIGNAL meter, the OSCILLATOR FREQUENCY CONTROL dial, and the three toggle switches is provided for use in monitoring and maintenance of the instrument. In normal operation these switches should be in the normal or automatic position.

3.5.1 The CONTROL switch opens and closes the AFC loop; in the AUTOMATIC position the loop is closed. If the loop is opened the output frequency of the standard may be varied manually over a range of about 6×10^{-7} by means of the OSCILLATOR FREQUENCY CONTROL.

3.5.2 The ACQUISITION switch controls the automatic acquisition circuit. In the DISABLE position the automatic frequency sweep recurs continuously (the sweep range is approximately that which can be effected manually by the OSCILLATOR FREQUENCY CONTROL). In the NORMAL position the sweep ceases

when the loop comes into lock.

3.5.3 Use of the SWEEP switch is required only in certain diagnostic maintenance tests; it should be left in the NORMAL position.

DESCRIPTION (continued)

The rubidium in which the resonance occurs is in the form of a vapor contained within a small glass cell. The cell itself is inside a resonant cavity excited by a signal at an integral multiple of the crystal oscillator frequency. Optical radiation generated in a rubidium discharge lamp and filter cell combination passes through the gas cell and considerably enhances the strength of the microwave resonance by the process of optical pumping. The extent to which optical radiation is absorbed in the gas cell depends on the relative absorption of microwave energy and, thus, provides a measure of the departure of the microwave excitation frequency from resonance. An error signal derived from detection of the transmitted optical radiation controls the crystal oscillator.

Temperature of the cavity and lamp are controlled in order to stabilize operating characteristics of each and to eliminate second-order variations of the atomic resonance frequency with temperature. Magnetic shielding of the gas cell eliminates the effects of variations in ambient fields. All active components are solid state devices, i.e., transistors and diodes, operating well derated; no unusual circuits are employed.

OPERATION

After initial warmup, the AFC loop is brought into lock by an automatic sweep system. Condition of the loop is indicated by the front panel lights. Routine maintenance is simple and can be performed using normally available laboratory test equipment. There are no moving parts or materials to be replenished.

Except for the optical-microwave unit, main power supply, and the crystal oscillator, all circuits are mounted on plug-in circuit boards. Nine such boards are used. The crystal oscillator, optical-microwave unit, and main power supply can each be replaced as individual entities. Plug-in circuit boards are interchangeable between standards without adjustment

OPERATION (continued)

or alignment. Replacement of interchangeable boards does not affect the frequency of the standard.

OPTIONS & ACCESSORIES AVAILABLE

Model 332-B Time Scale Selector

This accessory synthesizer can be installed in the 304-B to give it a versatility unequaled and previously unavailable in either atomic or crystal frequency standards. It achieves (1) quick changes of time scale value or (2)convenient calibration offsets by shifting the rubidium standard output with a precision of 1 part in 10^{11} to any desired value within the range 940×10^{-10}.

Model 311-A Standby Power Supply

Although rubidium frequency standards experience no shifting of frequency due to power outages, users keeping precise time must operate the standards continuously through power failures. The Model 311-A furnishes 8 hours of standby power from Nickel-Cadmium cells.

SPECIFICATIONS

Electrical

Initial Frequency Setting:	$\pm 5 \times 10^{-11}$ relative to customer prescribed frequency or time scale ($\pm 2 \times 10^{-11}$ if set at the National Bureau of Standards)
Accuracy:	After initial setting, Accuracy is determined by the Long-Term Stability.
Long-Term Stability:	5×10^{-11} (Standard Deviation) for one year
Medium-Term Stability:	5×10^{-12} (Standard Deviation) for 100 second averaging.
Short-Term Stability:	1×10^{-11} (Standard Deviation) for one second averaging time.

SPECIFICATIONS (continued)

Electrical (continued)

Tunability:	At least $\pm 1 \times 10^{-9}$ about the initial frequency setting; total range 4×10^{-9}. A calibration chart of frequency change vs. tuning control dial setting is provided.
Output Frequencies & Levels:	5 MHz, 1 MHz, 100 kHz; others, 1 kHz to 100 MHz, can be supplied; 1 volt rms at 50 ohms, each output.
Spectrum:	Equivalent bandwidth 1 Hz at 24 GHz, AC line frequency sidebands more than 100 db below carrier. Non-harmonically related signals more than 70 db below carrier.
Input Voltage:	90 to 130 VAC, 50 to 400 Hz, single phase, or 23 to 31 VDC. If both are applied, DC source provides power only if AC fails.
Operating Power:	35 watts AC, 30 watts DC
Warmup Power:	58 watts AC, 50 watts DC
DC Connector Supplied:	MS 3106A-10SL-3S

Environment Sensitivity

Ambient Temperature:	Long and short-term stability is maintained over the operating temperature range.
Magnetic:	Less than 5×10^{-12} for any orientation in the earth's magnetic field.
Operating Temperature:	0 to 45°C
Storage Temperature:	-65 to 100°C
Relative Humidity:	0 to 95%
Altitude:	0 to 40,000 feet.

SPECIFICATIONS (continued)

Physical

Size:	5-7/32" high x 16-1/2" long x 19" wide for standard rack mounting. (Also accepts Chassis-Trak CTD 118 slides).
Weight:	39 pounds.
Shipping Weight:	50 pounds.
Output Connectors:	Type BNC (front panel)

Controls and Indicators

Front Panel:	Loop lock indicator lights. AC power switch.
Internal Panel:	Crystal oscillator bias control, control loop error signal meter, automatic-manual sweep switch, acquisition disabling switch, sweep disabling switch, Fine tuning control.

Test Points	Regulated voltages, heater voltages, 2nd harmonic signal; all accessible from the rear of the standard.

DESCRIPTION

The GTC Model 304-B Rubidium Frequency Standard is an accurate, stable, compact, and rugged standard intended for general laboratory and field use. It consists of a quartz crystal oscillator whose frequency is automatically maintained at a subharmonic of the F=2, m=0, $\longrightarrow$ F=1, m=0 microwave resonance (6834.6826 MHz) in the ground state of rubidium 87. A synthesizer translates the oscillator frequency to outputs at standard frequencies.

Since the atomic resonance frequency is almost entirely unaffected by environmental factors, it provides a fixed and precisely known reference point in the radio frequency spectrum. This resonance is used as the discriminator of an AFC loop in which the crystal oscillator is the controlled element. Accordingly, the stability of the atomic resonance is transferred to the crystal oscillator.

DESCRIPTION (continued)

The rubidium in which the resonance occurs is in the form of a vapor contained within a small glass cell. The cell itself is inside a resonant cavity excited by a signal at an integral multiple of the crystal oscillator frequency. Optical radiation generated in a rubidium discharge lamp and filter cell combination passes through the gas cell and considerably enhances the strength of the microwave resonance by the process of optical pumping. The extent to which optical radiation is absorbed in the gas cell depends on the relative absorption of microwave energy and, thus, provides a measure of the departure of the microwave excitation frequency from resonance. An error signal derived from detection of the transmitted optical radiation controls the crystal oscillator.

Temperature of the cavity and lamp are controlled in order to stabilize operating characteristics of each and to eliminate second-order variations of the atomic resonance frequency with temperature. Magnetic shielding of the gas cell eliminates the effects of variations in ambient fields. All active components are solid state devices, i.e., transistors and diodes, operating well derated; no unusual circuits are employed.

OPERATION

After initial warmup, the AFC loop is brought into lock by an automatic sweep system. Condition of the loop is indicated by the front panel lights. Routine maintenance is simple and can be performed using normally available laboratory test equipment. There are no moving parts or materials to be replenished.

Except for the optical-microwave unit, main power supply, and the crystal oscillator, all circuits are mounted on plug-in circuit boards. Nine such boards are used. The crystal oscillator, optical-microwave unit, and main power supply can each be replaced as individual entities. Plug-in circuit boards are interchangeable between standards without adjustment

OPERATION (continued)

or alignment. Replacement of interchangeable boards does not affect the frequency of the standard.

OPTIONS & ACCESSORIES AVAILABLE

Model 332-B Time Scale Selector

This accessory synthesizer can be installed in the 304-B to give it a versatility unequaled and previously unavailable in either atomic or crystal frequency standards. It achieves (1) quick changes of time scale value or (2)convenient calibration offsets by shifting the rubidium standard output with a precision of 1 part in 10^{11} to any desired value within the range 940×10^{-10}.

Model 311-A Standby Power Supply

Although rubidium frequency standards experience no shifting of frequency due to power outages, users keeping precise time must operate the standards continuously through power failures. The Model 311-A furnishes 8 hours of standby power from Nickel-Cadmium cells.

SPECIFICATIONS

Electrical

Initial Frequency Setting:	$\pm 5 \times 10^{-11}$ relative to customer prescribed frequency or time scale ($\pm 2 \times 10^{-11}$ if set at the National Bureau of Standards)
Accuracy:	After initial setting, Accuracy is determined by the Long-Term Stability.
Long-Term Stability:	5×10^{-11} (Standard Deviation) for one year
Medium-Term Stability:	5×10^{-12} (Standard Deviation) for 100 second averaging.
Short-Term Stability:	1×10^{-11} (Standard Deviation) for one second averaging time.

SPECIFICATIONS (continued)

Electrical (continued)

Tunability:	At least $\pm 1 \times 10^{-9}$ about the initial frequency setting; total range 4×10^{-9}. A calibration chart of frequency change vs. tuning control dial setting is provided.
Output Frequencies & Levels:	5 MHz, 1 MHz, 100 kHz; others, 1 kHz to 100 MHz, can be supplied; 1 volt rms at 50 ohms, each output.
Spectrum:	Equivalent bandwidth 1 Hz at 24 GHz, AC line frequency sidebands more than 100 db below carrier. Non-harmonically related signals more than 70 db below carrier.
Input Voltage:	90 to 130 VAC, 50 to 400 Hz, single phase, or 23 to 31 VDC. If both are applied, DC source provides power only if AC fails.
Operating Power:	35 watts AC, 30 watts DC
Warmup Power:	58 watts AC, 50 watts DC
DC Connector Supplied:	MS 3106A-10SL-3S

Environment Sensitivity

Ambient Temperature:	Long and short-term stability is maintained over the operating temperature range.
Magnetic:	Less than 5×10^{-12} for any orientation in the earth's magnetic field.
Operating Temperature:	0 to 45°C
Storage Temperature:	-65 to 100°C
Relative Humidity:	0 to 95%
Altitude:	0 to 40,000 feet.

SPECIFICATIONS (continued)

Physical

Size:	5-7/32" high x 16-1/2" long x 19" wide for standard rack mounting. (Also accepts Chassis-Trak CTD 118 slides).
Weight:	39 pounds.
Shipping Weight:	50 pounds.
Output Connectors:	Type BNC (front panel)

Controls and Indicators

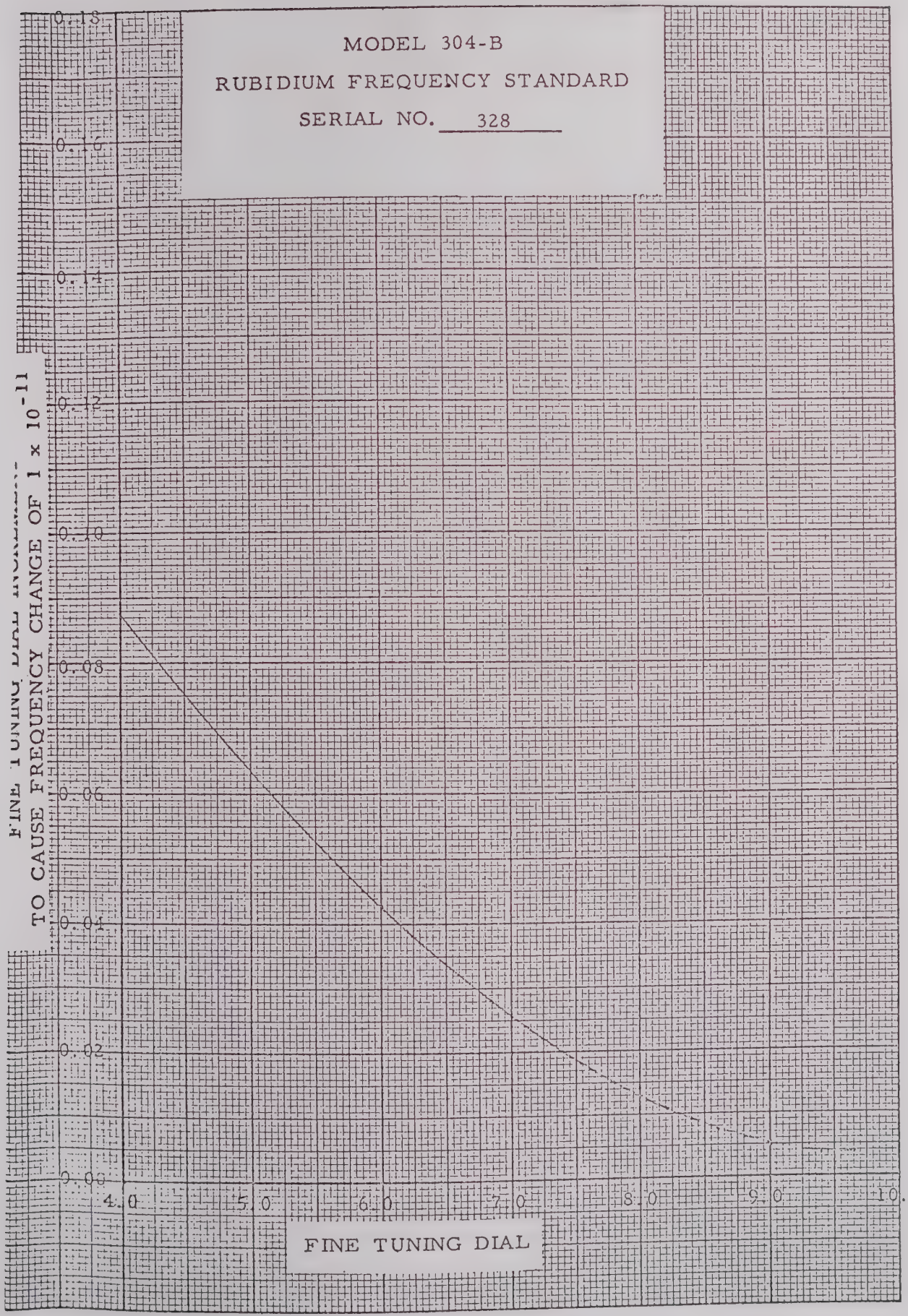
Front Panel:	Loop lock indicator lights. AC power switch.
Internal Panel:	Crystal oscillator bias control, control loop error signal meter, automatic-manual sweep switch, acquisition disabling switch, sweep disabling switch, Fine tuning control.

Test Points	Regulated voltages, heater voltages, 2nd harmonic signal; all accessible from the rear of the standard.

MODEL 304-B

RUBIDIUM FREQUENCY STANDARD

SERIAL NO. 328

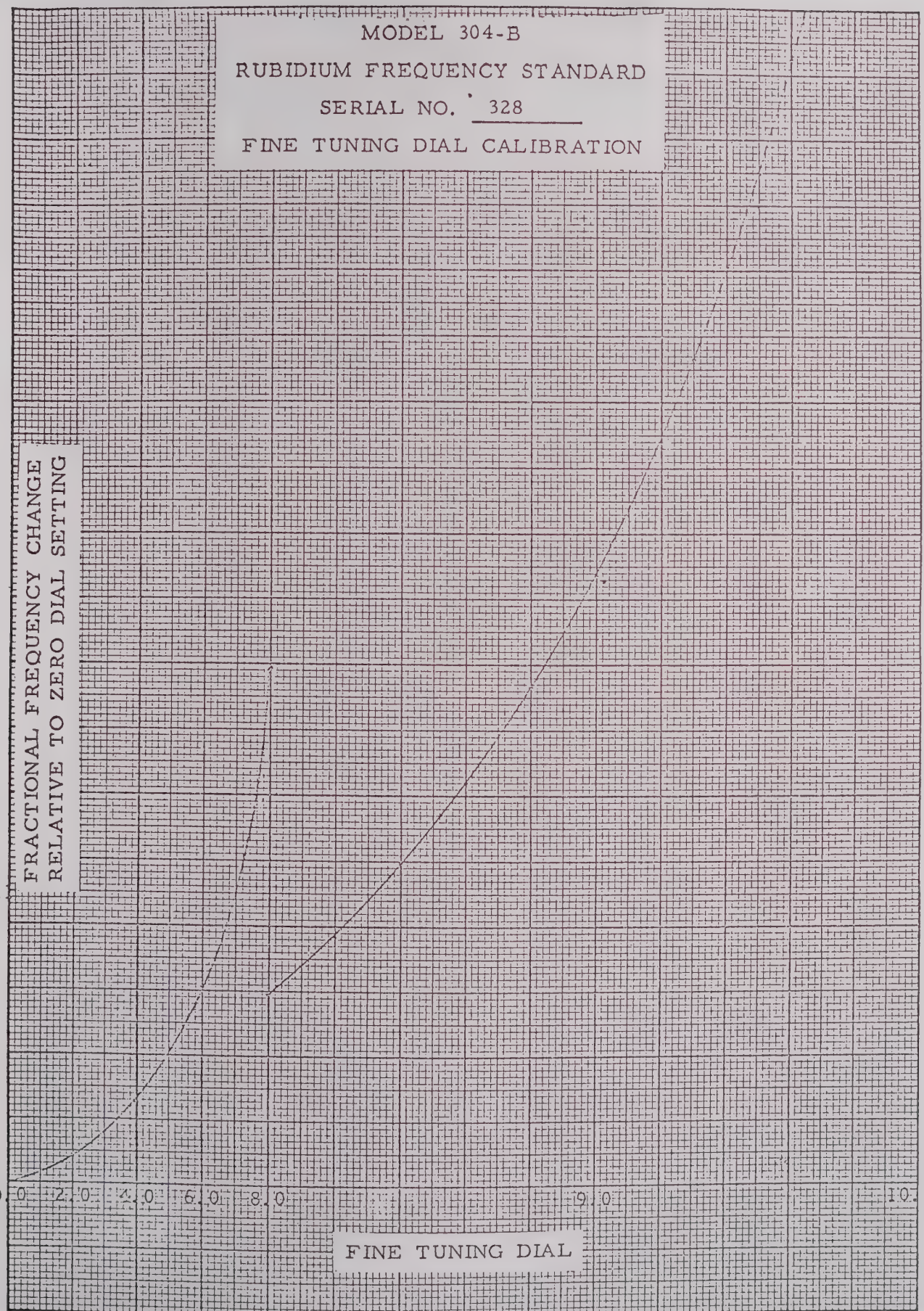


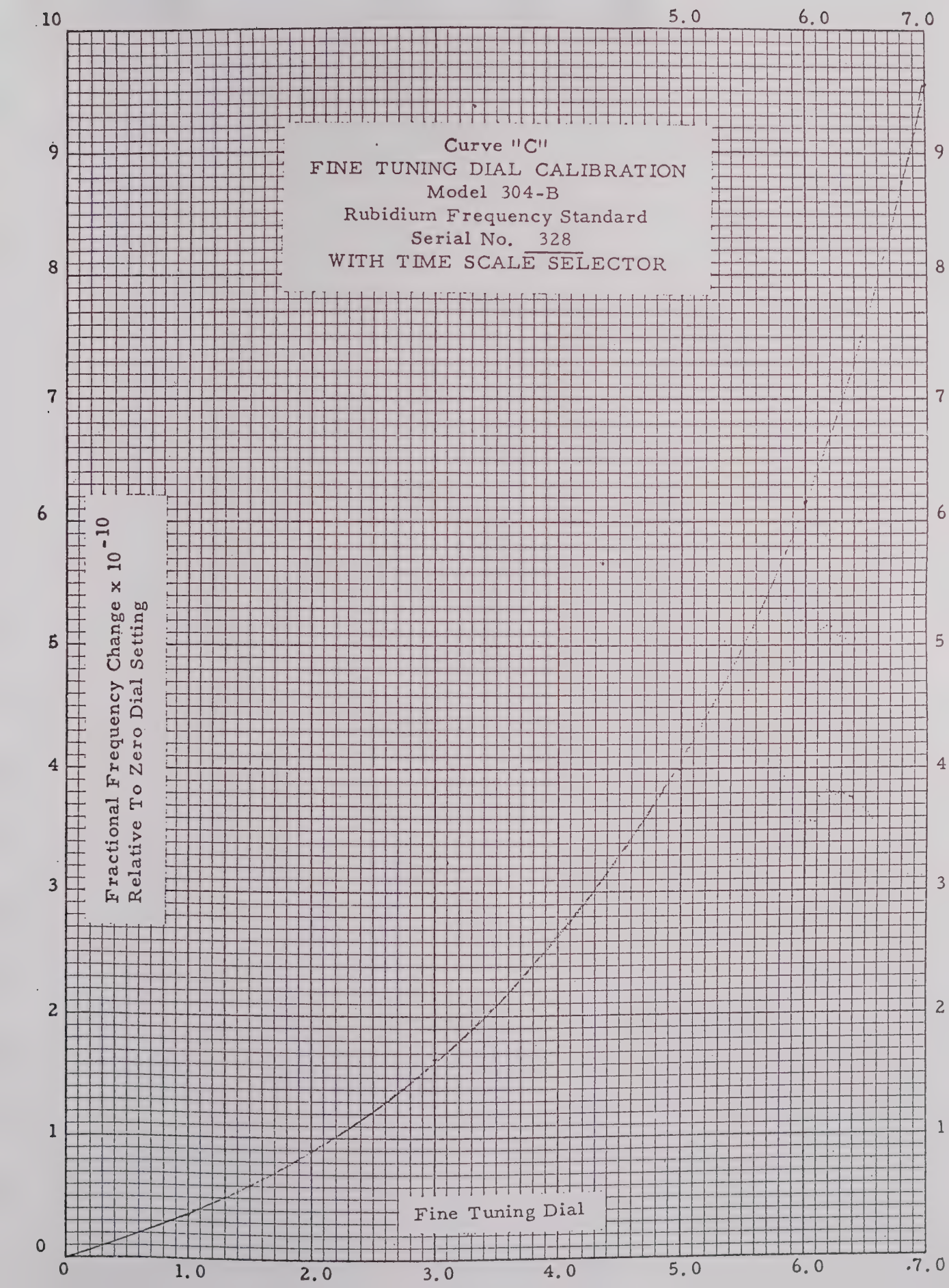
MODEL 304-B

RUBIDIUM FREQUENCY STANDARD

SERIAL NO. 328

FINE TUNING DIAL CALIBRATION



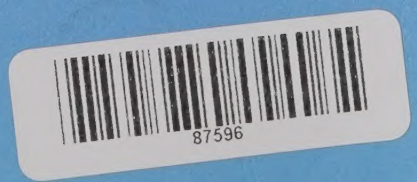

Curve "C"
FINE TUNING DIAL CALIBRATION
Model 304-B
Rubidium Frequency Standard
Serial No. 328
WITH TIME SCALE SELECTOR
Fractional Frequency Change x 10 -10
Relative To Zero Dial Setting
Fine Tuning Dial
10
9
8
7
6
5
4
3
2
1
0
5.0
6.0
7.0
0
1.0
2.0
3.0
4.0
5.0
6.0
7.0

Board	Test Point	Indication*
1	1. Cavity Heater	11.8 v DC**
	2. +20 Volts	20.0 ± 0.1v DC
	3. +15 Volts	15.0 ± 0.1v DC
	4. Oscillator Heater	14.2 v DC**
	5. +18 Volts	18.5 ± 0.5v DC
	6. Lamp Heater	11 v DC
	7. Ground	
5	1. 155 cps	155 ± 1 cps .7 v p-p
	2. Ground	
6***	1. 155 cps Signal	Narrow band noise centered at 155 cps. 1 to 2v p-p
	2. 310 cps Signal	Twice the frequency of TP 1 Board 5 8 - 9v p-p limiting waveform
	3. Ground	

* Values will depend somewhat on ambient temperature.

** With indicator impedance of 20,000 ohms per volt, or greater.

*** Indications are for AFC loop in lock.


87596